DYNAMIC PRICING IN AIRLINES: EFFICIENCY GAINS VS CONSUMER FAIRNESS IN THE MACHINE LEARNING ERA

CZU: [338.534:656.74]:004.89
DOI: https://doi.org/10.53486/tids2026.06

ANATOLIE BARACTARI
Academy of Economic Studies of Moldova
e-mail: baractari.anatolie@ase.md
ORCID ID: 0009-0005-7827-4946

ANATOLIE BARACTARI
Moldova Agroindbank
e-mail: toleabaractari@gmail.com
ORCID ID: 0009-0004-1407-6679

Abstract. Recent developments of machine learning models and technologies have significantly transformed the way that airlines view and create their pricing strategies within the industry. Traditional revenue management systems used to rely on static segmentation and historical demand patterns only. These are being replaced by newer models that use dynamic variables, which are capable of processing large volumes of real-time data. This paper tries to examine how such models can improve revenue management systems while trying to balance these improvements with the ethical concerns as well as customer fairness. The study will look at how modern pricing algorithms optimize airline revenues through forecasting demand, analyzing customer behavior, and assessing route profitability, as well as adapting to real-time market conditions. Using a qualitative research approach, supported by real-world case studies of international airline groups and industry reports, the paper analyzes the economic benefits generated by these machine learning models, including improved seat load factors, revenue maximization, as well as an increased market responsiveness. At the same time, the research looks at the ethical and social implication of highly personalized offers and pricing mechanisms. Particular attention is given to issues such as price discrimination, transparency and accessibility, as well as potential inequalities between customers. The paper discusses how such algorithm pricing can create perceptions of unfairness towards the company when customers are exposed to significantly different prices for a similar product or service. The findings of the paper suggest that machine learning-driven price strategies can significantly improve revenue maximization, efficiency, and competitiveness. However, it also concludes that increasing complexity and opacity of algorithm pricing systems need to be complemented by strong regulatory oversight, transparency standards, as well as ethical limitations to ensure customer trust and equitable market practices. The paper contributes to the ongoing discussion regarding the responsible implementation of AI in commercial aviation and digital business environments.

Keywords: Dynamic pricing, machine learning, airline revenue management, artificial intelligence, consumer fairness, revenue optimization

JEL Classification: L93, O33, C88, M21.

INTRODUCTION

Pricing has always been a crucial part and a decisive factor for profitability in the airline industry. The sector has high fixed operating costs and the main inventory is a perishable asset – airplane seats. Therefore, the companies need to implement complex systems in order to maximize revenues along with profitability while maintaining reasonable load factors, for both passengers and cargo (Belobaba, 1987). These management approaches were mostly based on historical booking trends and patterns, static fare classes and a few predefined customer segments. Back then, they

allowed airlines to estimate demand and adjust their prices accordingly and they were more than enough for the existing market (Talluri and Van Ryzin, 2004).

In recent years, digital technologies have grown exponentially and access to big data storage and processing has become relatively cheap. This has transformed the way pricing decisions are made as it allowed for real-time data collection and processing. Along with the advances made in the fields of artificial intelligence (AI) and machine learning (ML), this generates new ways of approaching price-setting and revenue management. Dynamic pricing has always been there for airlines, but it used to have this lag, a delay in responding to affecting factors. This step would reduce this delay dramatically and transform the industry, allowing carriers to react to real-time market conditions (Vinod, 2021). Airlines went from having a straight-line pricing method to tickets that change their value based on the weather and time of day. Modern pricing systems analyze in real-time large volumes of data on customer behavior, booking patterns, route performance, competitor prices, and external market conditions simultaneously, creating more accurate and responsive pricing decisions.

Industry reports and research papers have looked at the evolution of revenue management and pricing optimization over the past decades. Belobaba (1987) focused on yield management and seat inventory control as fundamental tools for airline profitability. He demonstrated how pricing and inventory decisions affects revenues. Talluri and Van Ryzin (2004) played with the theoretical framework of revenue management by analyzing demand forecasting, inventory allocation, and pricing optimization. More recently, Vinod (2021) looked at the integration of artificial intelligence into airline revenue management systems and underlined the importance of predictive analytics, real-time data processing, and automated decision-making.

Pricing mechanisms that are primarily based on machine learning models provide clear operational benefits. They do, however, generate multiple issues regarding transparency, fairness, as well as consumer trust. In the vision of the OECD (2019), the increased use of AI in commercial decision-making will require measures that will grant transparency and accountability so that public trust can be maintained. A similar conclusion was reached by Mittelstadt *et al.* (2016), who argued that algorithmic systems can create challenges related to bias and fairness. Explainability is an issue that arises here given the amount of personal and behavioral data that might be used in the process.

Therefore, using personalized pricing strategies could expose customers to different price brackets for a similar service or product, which, in its turn creates concerns about discrimination and/or (OECD, 2019). The topic becomes increasingly relevant as airlines continue to implement advanced algorithmic decision-making systems.

The aim of this paper is to examine the role of machine learning within airline dynamic pricing systems and evaluate the balance between operational efficiency and consumer fairness. To address this goal, the paper asks 3 main research questions

1. Which mechanisms does ML contribute with, that improve pricing compared to older, more static models?
2. Under what conditions do dynamic and personalized pricing mechanisms create risks to consumer fairness?
3. What governance measures can the industry implement to preserve the efficiency gains of the newer pricing models, while reducing the risks of unfair treatment of consumers?

By reviewing existing academic literature and industry practices, the paper investigates both the economic advantages and ethical implications of AI-driven pricing models in modern aviation.

1. MATERIALS AND METHODS

This paper adopts a qualitative research approach and is based on the review of academic literature as well as industry reports and airlines case-studies. The main goal is to assess the influence of machine learning algorithms on the pricing systems of airlines while evaluating the trade-offs between operational efficiency and consumer fairness as well as ethical concerns

The study starts from foundational research in the domain of revenue management in airlines. It draws on studies from Belobaba (1987) and Talluri and Van Ryzin (2004), as well as more recent literature focused on artificial intelligence and pricing optimization (Vinod, 2021). Additional insights regarding algorithmic transparency and ethical concerns were obtained from OECD (2019) and Mittelstadt *et al.* (2016). Industry publications from IATA (n.d.) and McKinsey & Company (2017) are also used throughout the research to identify the current trends and developments as well as practical aspects to align with the theoretical framework.

A comparative analysis was used to examine both the operational benefits and ethical challenges associated with machine learning-driven pricing systems. Applications such as demand forecasting, personalized pricing and real-time market adaptations were given particular interest as they generate value for airlines. The other side of the scales is weighed against the respective implications, including transparency, accessibility, fairness, and, importantly - trust.

The end goal is not to establish statistical relationships between certain variables. The paper looks to identify the key practices from existing literature and industry practices and provide a fair discussion of the advantages and challenges that AI-based pricing models bring to airlines and their customers.

2. RESULTS AND DISCUSSION

2.1 Evolution of Dynamic Pricing in Airlines

Dynamic pricing is both an old and new concept in the airline industry. It developed continuously over the years from traditional models that emerged with the deregulation of commercial aviation. The race for customers and profits, forced airlines to look for ways to improve their load factors by optimizing their pricing decisions. Because airline seats lose all economic value after departure, pricing optimization became one of the most important elements of airline profitability (Belobaba, 1987).

Traditional systems relied primarily on historical demand patterns, booking curves, seasonality, and fare classes (Talluri and Van Ryzin, 2004). While effective for their time, these systems had limited ability to respond to sudden market changes and rapidly evolving customer behavior.

As previously stated, the emergence of big data analytics changed the way pricing was built for airlines, not only to develop dynamic pricing, but also to create personalized offers. Airline groups as well as smaller companies realized that they could collect various data from their customers and use it to increase value creation for those same customers. These new models are able to process big amounts of data in real time while keeping cost at an acceptable level. Therefore, based on browsing behavior and booking preferences, airlines are able to update their best offers more often. Combined with data on route performance as well as weather and other external factors, models are theoretically able to generate almost optimal price decisions, therefore maximizing load factors and profits (Vinod, 2021).

2.2 Machine Learning Applications in Airline Pricing

ML models are now sitting at the centre of multiple airlines' pricing systems and CRMs. Such models are able to determine new trends and patterns as well as the underlying factors (Davenport and Ronanki, 2018). Their approach pays attention to price drivers that most older models would simply overlook. One of their most important applications is demand forecasting. Predictive models are able to analyze booking trends, seasonality, economic conditions, and customer behavior in order to estimate future demand more accurately (McKinsey & Company, 2017).

Another important application involves personalized pricing and offer creation. Through the analysis of browsing history, booking behavior, travel frequency, and customer preferences, airlines can develop highly targeted offers that increase the probability of purchase while improving revenue performance (IATA, n.d.).

ML-driven models are also used for analyzing route profitability, on one hand, these can potentially propose route remapping or even closures and on the other hand discover new route opportunities. The process is based on continuous performance review, competitor pricing monitoring as well as booking velocity analysis. Combined with external disruptions or events, such a model is able to react almost instantly allowing the airline to be the first to react. This has strategical as well as brand-image implications and is crucial in such a competitive market.

2.3 Efficiency Gains and Operational Benefits

The implementation of machine learning-based pricing systems has are throretically proven able to generate substantial benefits for airlines. Research shows that they could provide improvements of RASK (Revenue per available seat kilometer), which is a very important industry metric. It shows how well an airline manages their inventory and seats along their routes. Having more accurate demand forecasts improves seat allocation between economy and business classes and airplanes can adjust seating layouts flight-on-flight to maximize revenue (IATA, n.d.). It can also optimize ticket prices according to expected demand levels further improving customer "happiness" as it predicts the maximum amount they are willing to pay, therefore meeting their expectations while still making profits (Vinod, 2021; Weatherford and Belobaba, 2002)

Machine learning models also increase responsiveness to rapidly changing market conditions. Unlike traditional systems that often require manual intervention, modern pricing algorithms can react almost instantly to competitor actions, booking trends, and market disruptions (McKinsey & Company, 2017).

A great addition of automated pricing is that it actually reduces operational complexity long term and greatly improves scalability for larger networks. This is particularly good for airlines groups such as Air-France KLM, Lufthansa Group or United as they can afford to invest into this and then scale it up to the whole network. These technologies have now become central for most airlines and represent a great component of the broaden digital transformation strategies (IATA, n.d.).

2.4 Consumer Fairness and Ethical Challenges

Despite their operational advantages, machine learning-driven pricing systems also create important ethical concerns. The biggest and most discussed issue is price discrimination. Highly personalized pricing strategies often result in customers receiving significantly different prices for similar services under comparable conditions (European Commission, 2021).

That issue can quickly escalate into legal problems and potential financial and reputational losses. When paired with the lack of transparency on how algorithmic pricing decisions are made,

this increases the customers' concerns regarding fairness and accountability (Wirtz et al. 2023) Currently, customers do not have access to data describing specifically which factors influence the final price they receive, this makes it complicated to evaluate whether pricing is fair and justified (OECD, 2019).

These concerns are not only specific to the airline industry and can be directly linked to the broader debates around the ethics of algorithmic systems. Mittelstadt *et al.* (2016) argue that algorithmic systems may introduce bias, information asymmetry, and accountability challenges that are often difficult for consumers to identify or challenge. Given how quickly automated pricing is spreading through our societies and becoming present in most industries and aspects of life, it is important to stay transparent. Taking the time and resources to explain such decisions to one's customers through a brief note or a separate page, may become a crucial part of customer trust and subsequently, success.

Another pressing matter is related to personal data handling. Regional laws like the GDPR or other local data protection regulations may restrict the usage of personal and behavioral data within pricing systems. The enitity would need to provide legal reason for collecting, storing and using these data. According to Mittelstadt *et al.* (2016), algorithmic systems can unintentionally reinforce existing inequalities when decision-making processes rely on incomplete or biased data. Therefore, bias can appear in systems that are thought to be objective and unbiased.

The key benefits and challenges identified throughout the literature review are summarized in Table 1. The framework highlights that while machine learning creates substantial operational and financial advantages for airlines, it also introduces concerns related to transparency, fairness, and consumer trust.

Table 1. Key benefits and challenges identified throughout the literature review.

Evaluation Dimension	Positive Impact	Associated Risk
Revenue Performance	Revenue maximization	Over-optimization at customer expense
Operational Efficiency	Faster and more accurate pricing decisions	Reduced human oversight
Market Responsiveness	Real-time adaptation	Greater price volatility
Personalization	More relevant offers	Perceived discrimination
Data Utilization	Better decision quality	Privacy concerns
Consumer Trust	Improved customer experience when transparent	Reduced trust when pricing is opaque
Regulatory Compliance	Supports innovation	Increased scrutiny under AI regulations

Source: *Prepared by the authors based on a review of the literature.*

2.5 Discussion

The present analysis shows that ML technologies do in fact improve airline revenue management. By implementing better forecasting, dynamic optimization and real-time responsiveness, they are able to increase revenues and profits. The results additionally confirm the initial research, underlining that AI is able to create positive impacts on operational efficiency (Vinod, 2021).

At the same time, the research demonstrates that the benefits of machine learning must be balanced against concerns regarding transparency, fairness, and consumer trust. Personalized pricing may improve economic performance, but it may also create a perception of unfairness among customers. This could potentially undo all of the benefits of the newly implemented software or even do more damage. Therefore, this matter must be treated responsibly and in a timely manner.

The main contribution of this paper if the attempt to create a parallel between increased profits and customer fairness. Through this comparison, one can see how changes in one affect the other and vice versa, often pulling against one another. Therefore, a balanced state is needed for airlines to maintain a continuous business pipeline. Studies with similar topics focus on revenue optimization models and primarily reveal the benefits of such implementations. This research does not debate the value of ML models and the additional value they bring, it shows how important it is to balance technological innovation and consumer fairness. This perspective is consistent with the growing literature on algorithmic ethics, which insists that artificial intelligence systems should be evaluated not only through efficiency gains but also through their impact on transparency, accountability, and fairness (Mittelstadt *et al.*, 2016)

CONCLUSIONS

Machine learning technologies have fundamentally transformed airline pricing strategies by enabling real-time data processing, improved demand forecasting, and automated revenue optimization. These capabilities provide airlines with opportunities to improve operational efficiency, maximize revenue, and strengthen their competitive position.

However, the growing adoption of algorithmic pricing systems also raises significant ethical concerns. Issues related to transparency, accessibility, discrimination, and consumer trust demonstrate that technological efficiency alone is not sufficient for the responsible implementation of artificial intelligence in commercial aviation.

The main contribution of this paper is the examination of both the economic and ethical dimensions of machine learning-driven pricing systems. The findings suggest that the long-term success of such technologies depends on maintaining a balance between revenue optimization, operational efficiency, transparency, and consumer fairness, as illustrated by the evaluation framework presented in Table 1.

One limitation of this study is its reliance on secondary data and qualitative analysis. Future research could employ quantitative methods using airline pricing datasets in order to measure the direct relationship between machine learning implementation, revenue performance, and customer behavior. Such research would provide valuable insights into how airlines can leverage artificial intelligence while maintaining transparency and consumer trust.

REFERENCES

Belobaba, P., 1987. Airline Yield Management: An Overview of Seat Inventory Control. Transportation Science, 21(2), pp. 63–73.

Davenport, T.H. and Ronanki, R., 2018. Artificial Intelligence for the Real World. Harvard Business Review, 96(1), pp. 108–116.

European Commission, 2021. Proposal for a Regulation Laying Down Harmonised Rules on Artificial Intelligence. Brussels: European Commission.

IATA (n.d.). *Dynamic offers.* Available at: https://www.iata.org/en/programs/airline-distribution/retailing/dynamic-offers/ [Accessed 08.05.2026].

McKinsey & Company, 2017. How airlines can gain a competitive edge through pricing. Available at: https://www.mckinsey.com/industries/travel/our-insights/how-airlines-can-gain-a-competitive-edge-through-pricing [Accessed 12 May 2026].

Mittelstadt, B.D., Allo, P., Taddeo, M., Wachter, S. and Floridi, L., 2016. The Ethics of Algorithms: Mapping the Debate. Big Data & Society, 3(2), pp. 1–21.

OECD, 2019. OECD Principles on Artificial Intelligence. Paris: OECD Publishing. Available at: https://oecd.ai [Accessed 14.05.2026].

Talluri, K.T. and Van Ryzin, G.J., 2004. The Theory and Practice of Revenue Management. Boston: Springer.

Vinod, B. (2021). Artificial intelligence in travel. Journal of Revenue and Pricing Management, 20(3), 368–375.

Weatherford, L.R. and Belobaba, P.P., 2002. Revenue Impacts of Fare Input and Demand Forecasting Accuracy in Airline Revenue Management. Journal of the Operational Research Society, 53(8), pp. 811–821.

Wirtz, J., Kunz, W.H., Hartley, N. and Tarbit, J., 2023. Corporate digital responsibility in service firms and their ecosystems. Journal of Service Research, 26(2), pp. 173–190.